doi:10.7289/V5FQ9TJW

GSICS Quarterly

Global Space-based Inter-Calibration System

CMA • CNES • EUMETSAT • JMA • KMA • NASA • NIST • NOAA • WMO

http://gsics.wmo.int

Vol. 4, No. 1, 2010

Dr. Robert A. Iacovazzi, Jr., Editor

TRUTHS: A benchmark mission for climate and GEOSS

Overview

TRUTHS (Traceable Radiometry Underpinning Terrestrial- and Helio- Studies) is a small satellite mission proposal first submitted to an European Space Agency (ESA) call in 2002. It is now being updated for re-submission later this year to the ESA EE-8 call. The mission's primary objective, *establishing SI-traceable benchmark measurements from space*, or "a *standard laboratory in space"* is synonymous with the long-term strategy of GSICS, and that of Climate Absolute Radiance and Refractivity Observatory (CLARREO), currently under consideration in the USA. Although TRUTHS additionally incorporates absolute measurements of incoming solar irradiance, its reference measurements of the Earth are limited to the solar reflective domain. The international nature of many of the objectives of such missions ideally warrants an internationally coordinated effort, recognising this has led to mutual representation on respective mission science teams as a first step.

The TRUTHS mission scope can be summarised by the following:

- **Robust high-accuracy observation of long-term climate change trends**
  - Incoming total and spectrally-resolved solar irradiances
  - Spectrally-, spatially- and angularly-resolved, Earth reflected solar radiances;
- **Observations of sufficient accuracy to test and improve climate forecasts**
  - Reduce uncertainty in key climate feedbacks: clouds, albedo, land cover, aerosols, water vapour
  - Establish reliable benchmarks for future generations
  - Unequivocal attribution of climate change to anthropogenic origins (where appropriate) from background of natural variability;
- **Enable full interoperability of international satellite observing systems, e.g., GEOSS, GMES, and CEOS constellations, and facilitate existing and future operational sensors to deliver climate quality data.**
  - Evaluation and removal of biases
  - SI-traceable in-orbit calibration reference to improve accuracy
  - Improved atmospheric radiation propagation algorithms.

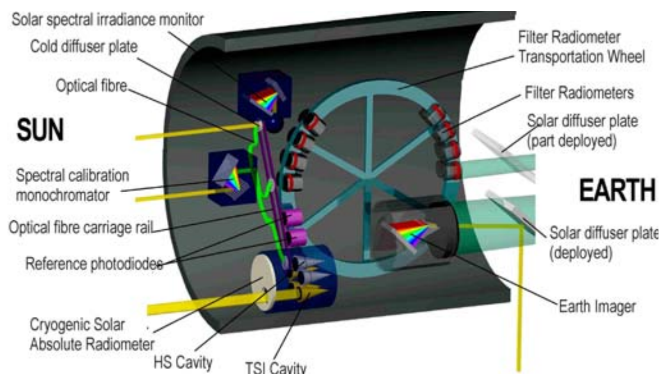

Figure 1. Schematic representation of the TRUTHS satellite and payload.

Concept

Shown schematically in Figure 1 is a small pointable satellite based mission (Surrey satellite Technology Ltd), with a payload comprising of a hyper-spectral Earth-viewing Imager (390 to 2500 nm) with ground resolution 30-100 m (TBD) and uncertainty of <0.3%, together with a set of polarised spectrally filtered radiometers for aerosol characterisation. Its solar viewing axis has radiometers to measure total and spectrally-resolved solar irradiances with uncertainties of 0.01 and 0.1 % respectively. The unprecedented accuracies of TRUTHS are achieved through a unique in-flight calibration system which mimics that employed on the ground at national metrology institutes (NMI) such as NPL and NIST to realise primary radiometric scales. This traceability chain is described in the following companion article.

[by Dr. N. Fox, Nigel.Fox@npl.co.uk, (National Physical Laboratory, UK)]

TRUTHS: SI Traceability

The TRUTHS traceability chain is shown schematically in Figure 1 (see next page). The heart of this traceability chain is the Cryogenic Solar Absolute Radiometer (CSAR). CSAR, cooled to ~20 K by an Astrium space cooler, is a "primary" SI radiometric standard based on a concept pioneered by NPL in the 1980's and now used at many of the world's NMI's (Fox 1995, Fox and Rice 2005, and Martin and Fox 1994). A fully operational engineering model of CSAR is currently under construction by NPL and the World Radiation Centre in Davos

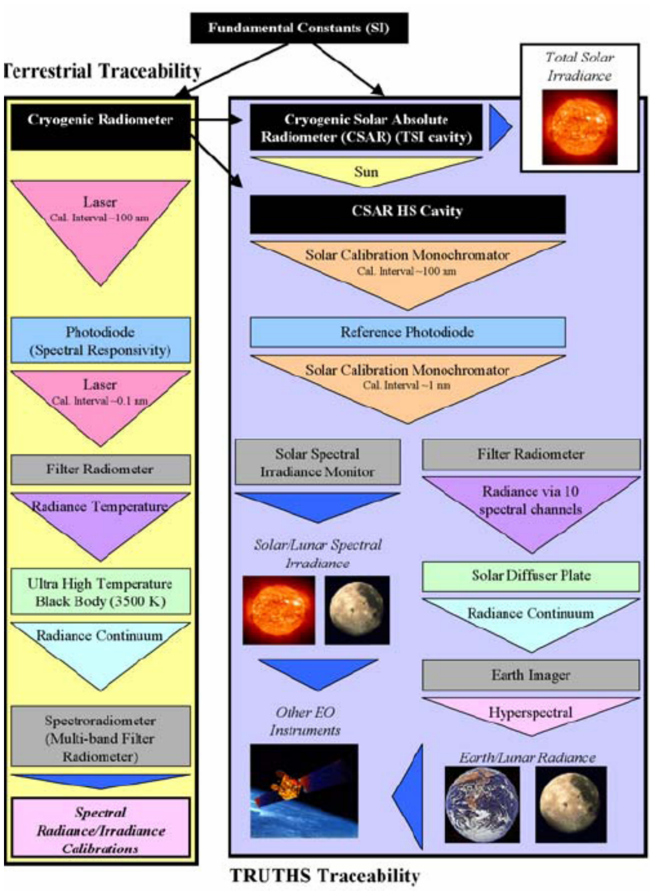

Figure 1. SI Traceability chain for TRUTHS contrasted with that of a terrestrial NMI.

(PMOD-WRC) and will be ready for deployment in the Summer of 2010 for measurements of terrestrial solar irradiance. It is intended that CSAR should eventually become a replacement for the World Radiometric Reference, and would of course provide similar capability in space.

Terrestrial

The typical terrestrial calibration chain for spectral radiance employed by an NMI such as NPL is shown in the left-hand column of Figure 1. A cryogenic radiometer (primary standard) measures the radiant power in a monochromatic beam of radiation, from a laser, by comparing its heating effect with that of electrical power. Uncertainties of 0.001% can be achieved in this way. The now calibrated monochromatic beam is then used to illuminate a photodiode and thus determine its spectral response. This can be repeated at sufficient wavelength intervals to allow interpolation of the slowly varying spectral response of the photodiode. These photodiodes can then be used to calibrate the radiance response of spectrally selective detectors (filter-radiometers) using a similar monochromatic beam of radiation but at much finer spectral intervals, using a tuneable laser source. These filter radiometers can then measure the spectral radiance or irradiance of an unknown source, e.g. lamp, lamp illuminated diffuser/sphere or blackbody. Measuring the latter allows, through Planck's law, the determination of the blackbodies temperature and subsequently its spectral emittance at all other wavelengths, enabling it to become a calibration reference for any spectral radiometer or other transfer standard source, that might for example be used for the pre-flight calibration of a satellite imager.

TRUTHS

An analogous calibration procedure is proposed for TRUTHS (Fox et al. 2003), illustrated in the right hand column of Figure 1. The main difference is that TRUTHS utilises solar radiation dispersed by a monochromator for spectral responsivity calibrations instead of lasers. Only short-term (minutes) stability of the radiation from the monochromator is required as any long-term degradation is calibrated out each time it is used, by referencing the output beam power to the onboard primary standard, CSAR. This beam can subsequently be used as an absolute tuneable monochromatic source to calibrate other instrumentation.

The TRUTHS Imager is calibrated in-orbit through a measurement of solar irradiance reflected from a solar illuminated diffuser plate instead of a high-temperature black body. This procedure is in common use, e.g., MERIS on Envisat. However, in contrast to other EO missions, the spectral radiance of this system is measured directly in-orbit using a group of filter-radiometers regularly recalibrated against CSAR, the SI primary standard, removing errors due to drifts in spectral shape and absolute level caused by ageing or contamination.

Calibration Satellite

Flying in a <90° orbit allows frequent "cross-overs" with other in-flight sensors. Together with its own pointing capabilities and high spatial and spectral resolution (enabling a tailored match to other sensors) allows the transfer of its high calibration accuracy and SI traceability to other sensors through simultaneous nadir observations (SNO) of the same target. These calibration opportunities are extended by regular observations of CEOS endorsed reference standard targets: the Moon, invariant deserts and Landnet sites (CEOS 2009) enabling TRUTHS to establish and update their TOA radiometric characteristics. Based on the original ideas of Teillet et al (2001), the IVOS sub-group of CEOS WGCV has started work to prototype the integration and potential automation of such a network of sites as a future "operational calibration service" for the EO satellite community. In this paradigm, illustrated in Figure 2, geostationary imagers are not only calibrated by TRUTHS but can also serve as transfer standards and monitor temporal drift of ground targets between re-visits of TRUTHS.

TRUTHS not only provides "operational" and scientific sensors with reliable traceability for their original core objectives, but in many cases also enables their performance to be enhanced to enable climate quality data to be obtained. In some cases this may also allow improvements to be made to the accuracy of archived data, allowing climate reference

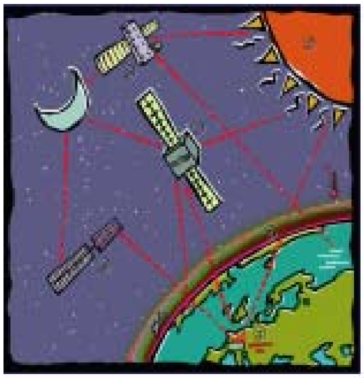

Figure 2. Schematic of the TRUTHS calibration.

baselines to be established earlier than would otherwise be possible.

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[by Dr. N. Fox, Nigel.Fox@npl.co.uk, (National Physical Laboratory, UK)]

Inter-calibration results analysis for FY-2C/2D based on AIRS and IASI

Feng Yun (FY)-2C/2D are consecutive operational satellites of China's first generation of geostationary satellites. The main sensor on them, the Visible Infrared Spin-Scan Radiometer (VISSR), has five bands including two split-window IR, water vapor, midwave-IR and visible channels. FY-2C was launched on 19 October 2004 and located at 105^{o}E. It began to run operationally March 2005 and finished its mission 25 November 2009, when it was replaced smoothly by FY-2E at the same time and location. FY-2D was launched on 8 December 2006, located at 86^{o}E and is still operating on orbit.

In September 2009, the CMA GSICS Processing and Research Center (GPRC) established GEO-LEO IR routine inter-comparisons of FY-2C/2D with the Atmospheric Infrared Sounder (AIRS) and Infrared Atmospheric Sounding Interferometer (IASI) hyperspectral sounders (HS). This has been achieved utilizing JMA codes, developed as part of GSICS collaboration, that have been adjusted to interface with the normal FY-2C/2D L1 data and their spectral response function (SRF) files. The JMA spectral compensation method is also used for spectral gap filling of HS (Tahara 2008 and 2009). The real-time results can be found on the web (http://fengyunuds.cma.gov.cn/gsics). IASI and AIRS data is ordered and downloaded from NOAA and NASA servers, respectively. The GEO-LEO IR Inter-calibration Algorithm Theoretical Basis Document (ATBD) of CMA is almost the same as JMA (Owada 2009), except for some differences in collocation criteria. The baseline collocation algorithms used in this inter-calibration are determined by the GSICS Research Working Group (Wu, 2008). To compare data between FY-2C/2D and AIRS/IASI, near-simultaneous observations are first collocated. Then, the radiances observed by HS channels are convolved according to the spectral responses of the FY-2C/2D infrared channels to estimate their radiances as well as the spectral compensation.

The footprint sizes of AIRS and IASI are about 12-13 km at nadir, whereas that of the FY-2C/2D infrared channels is 5 km. Sounder radiance (L_{Sndr}) is compared with an average value for FY-2C/2D radiances over a box of 3 × 3 pixels ($\overline{L}_{3x3FY}$) corresponding to the sounder footprint. The FY-2C/2D and HS data are selected for collocation based on the following criteria: Observation time difference is less than 10 minutes and $\left|\cos(\theta_{Sndr})/\cos(\theta_{FY2C/D})-1\right| < 0.01$ (θ is the solar zenith angle). In addition, only measurements over uniform scenes are selected and compared. In this check, the uniformity of FY-2C/2D radiance data in an environment defined by a box of 9 × 9 pixels is tested using the standard deviation $\sigma_{9x9FY} < 0.05$ mWsr^{-1}m^{-2}. If these tests have been successfully completed, the parameters L_{Sndr} and $\overline{L}_{3x3FY}$ are compared for collocated pixels. The normality of the FY-2C/2D radiance data in the 3 × 3 pixel region is checked using with the expression $|\overline{L}_{3x3FY} - \overline{L}_{9x9FY}| \times 9 / \sigma_{9x9FY} <$ Gaussian (3.0).

All in-flight operational data of FY-2C/2D are collected for calibration reprocessing. The date coverage of FY-2C is from June 2005 to the end of 2009, and of FY-2D is from May 2007 to now. Inter-calibration regression analysis is conducted everyday based on the collocation data during the previous 5 days. FY-2C recalibration processing for the whole instrument lifetime is already finished. FY-2D/2E calibration monitoring is ongoing. The following is the calibration result analysis of FY-2C/2D based on AIRS and IASI.

In Figure 1, FY-2C L1 calibrated (brightness temperature (Tbb) bias trend with respect to AIRS during the whole FY-2C lifetime is shown. At the 290 K reference scene, FY-2C calibration bias of IR1 (10.3-11.3 µm) and IR2 (11.5-12.5 µm) has an apparent seasonal fluctuation and leads to the significant deviation of Tbb bias, especially after 2007. The

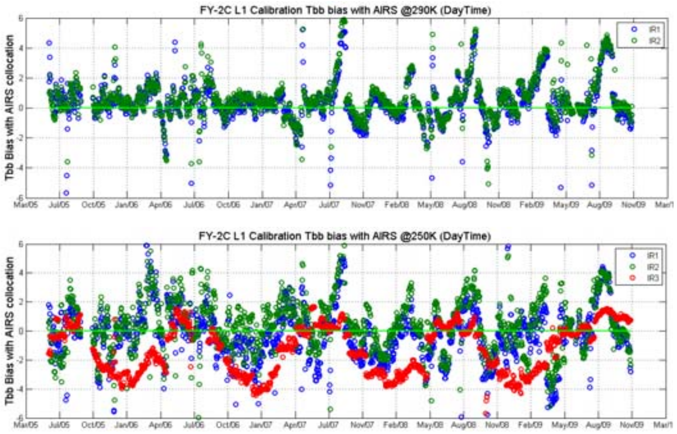

Figure 1. FY-2C L1 calibrated Tbb bias trend with AIRS during the whole liftetime. The top is Tbb bias with AIRS at 290 K reference scene for IR1 and IR2 (split windows bands). The bottom is Tbb bias with AIRS at 250 K reference scene for IR1, IR2 and IR3. IR3 is the water vapor band.

maximum Tbb bias is more than 5 K. The Tbb bias during much of Winter-Spring of the first two years is smaller than 0.5 K. According to instrument cavity and cooler temperatures, the sensor is operating stably during this time period. There are anomalously large Tbb biases in some isolated days due to a FY-2C image navigation error that occurred when the satellite orbit was adjusted. At 250 K reference scene, FY-2C calibration bias of IR3 (water vapor band, 6.3-7.6 μm) has the flat cyclical fluctuation. The bias is small during May to September every year except for July, 2006. The relatively bigger negative bias appears in other months and the biggest bias in January. These results of FY-2C Tbb bias agree well with Gunshor (2009). In addition to this, IR1 and IR2 bias values are different, which will lead to an additional bias of Brightness Temperature Difference (BTD) of two split window bands of FY-2C, affecting retrieval accuracy of some L2 products using this BTD.

The differences between the FY-2C/AIRS biases and the FY-2C/IASI biases (double difference) is indicative of the relative performance of AIRS and IASI. On average, we find that the double difference (not shown) is less than 0.5 K and stable for long term for the 290 K data. But some anomaly values and small fluctuations of these double differences appear at the lower 250 K reference scene for IR1 and IR2. The anomaly points should be eliminated and filtered when GSICS correction and recalibration are conducted for FY-2C historical data.

Figure 2 shows the Tbb bias results for FY-2D with respect to AIRS, which are presented similarly as Figure 1. The trend of Tbb bias for FY-2D has a significant cyclical fluctuation and reaches 4 K to 6 K every September during the Autumn eclipse phase. The bias trend of FY-2D is relatively more stable than FY-2C. There are also some anomaly values points due to the navigation error just after orbit adjustment. The bias of the water vapor band is at the same order (-4 K to 1 K) as

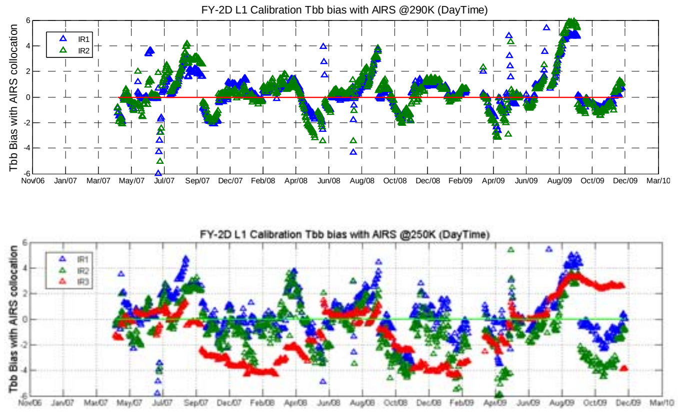

Figure 2. FY-2D L1 calibrated Tbb bias trend with AIRS since May, 2007. The top is at 290 K reference scene for IR1 and IR2 (band names is same as FY-2C). The bottom is at 250 K reference scene for IR1, IR2 and IR3.

FY-2C, but a bigger positive bias (about 3 K) appears after August 2009. The FY-2D bias double difference with AIRS and IASI (not shown) is for the most part relatively small and stable during long period, similar as the result of FY-2C inter-calibration.

FY-2C/2D IR4 (Midwave-IR) had some problems during the period when the inter-calibration is conducted due to stray-light contamination at night and solar reflective effects during the daytime. The IR4 radiance dynamic range of GEO-LEO collocation samples at low latitude area is very limited for this inter-calibration, but the high signal design of this channel is for fire monitoring. So, more work is needed to diminish those errors.

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[by Drs. X. Q. Hu, P. Zhang, Y. Zhang (NSMC/CMA)]

Investigating GOES Sounder Channel 15 bias using IASI

The sounding instrument launched on each Geostationary Operational Environmental Satellite (GOES) since 1994 measures the radiation in 1 visible and 18 IR channels over the continental United States (CONUS) and adjacent oceanic regions with high temporal resolution. The derived products, including atmospheric temperature and moisture profiles, surface and cloud-top temperatures and pressures, atmospheric stability indices, and ozone distribution, have proved useful for weather forecasting and environmental monitoring. More quantitatively, GOES Sounder measured radiances have been directly assimilated into numerical weather prediction (NWP) models for weather forecasting and next-generation re-analysis datasets. Therefore, high data quality with precise and accurate calibration is highly desired for GOES Sounder measurements.

Since the launch of the GOES-10 Sounder, it has been known that the observations from the GOES Sounder Channel 15 (with central wavenumber 4.3 µm and weighting function ~300 hPa) has relatively large biases (more than 6 K) compared to radiative transfer calculations. However, the root cause has not been fully understood. The hyperspectral radiance measurements from the Infrared Atmospheric Sounding Interferometer (IASI) carried on Metop-A, which offer inherent advantages for both spectral and radiometric calibration accuracy, allow reinvestigation of the bias from the GOES Sounder Channel 15. We convolved the IASI hyperspectral measurements with the GOES Sounder spectral response functions (SRFs) to compare with the simultaneously collocated GOES Sounder observations. Preliminary results indicate that the bias is likely caused by possible errors in the GOES Sounder SRF. Figure 1 shows the scatter plot of the IASI-simulated GOES Sounder observations versus simultaneously collocated GOES observations, which clearly shows the bias change before and after the spectral shift (+10.3 cm^{-1}). This newly developed capability will allow spectral calibration for GOES Imager and Sounder IR channels using inter-calibration to resolve SRF-induced radiance bias, which will improve satellite data utilization by providing more accuracy radiances for NWP.

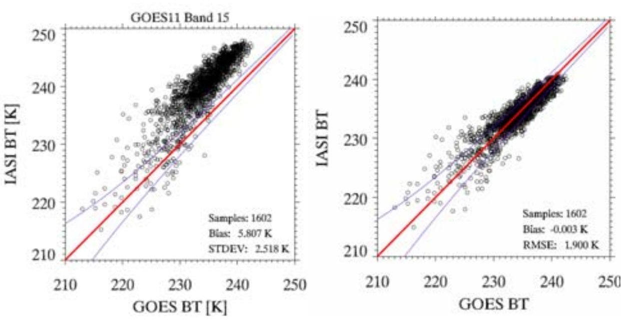

Figure 1. IASI observations convolved with the GOES-11 Sounder SRF for Channel 15 are compared with *simultaneously collocated GOES observations* before (left) and after (right) the SRF shift (+10.3 cm^{-1}). The blue lines indicate the Noise Equivalent Delta Temperature (NEDT) values.

[by Drs. L. Wang and C. Cao (NOAA/NESDIS)]

News in this Quarter

GSICS Executive Panel - Seventh Meeting

The seventh meeting of the GSICS Executive Panel (EP) was held on 30 October 2010 in Jeju, Republic of Korea. The EP Chair, Mitch Goldberg, welcomed the participants, which included the Director of the WMO Space Programme, Barbara Ryan, the Chair of the CEOS Working Group on Calibration and Validation (WGCV), Pascal Lecomte, and observers from the Japan Aerospace Exploration Agency (JAXA) and the Indian Space Research Organization (ISRO). So, nearly all CGMS satellite operators were represented at the meeting.

During the meeting, Dr. Lecomte recalled the scope of the Quality Assurance Framework for Earth Observations (QA4EO), and reported on the outcome of the “QA4EO Workshop on Facilitating Implementation” held in Antalya, Turkey from 29 September to 1 October 2009. Important participation in the workshop has shown that QA4EO attracts interest from an increased number of organizations, space and non-space oriented. GSICS for some time has recognized the importance of QA4EO, and Dr. Goldberg presented a comprehensive report on the status of the GSICS Procedure for Product Acceptance (GPPA), which is based on QA4EO principles and guidelines. Their report showed the progress towards acceptance of GEO-LEO (IR) and LEO-LEO (VIS, IR, MW) products. The GSICS Coordination Center (GCC) however suggested that important steps should be completed before the first GSICS products are accepted.

The EP-VII meeting also spotlighted discussions regarding the outcome of the GSICS Users Workshop that was held in Bath, United Kingdom on 22 September, in the context of the 2009 EUMETSAT Meteorological Satellite Conference. The workshop was very successful, attracting more than 60 participants, and providing valuable feedback and suggestions in spite of the still emerging status of GSICS activities.

Most of the remainder of the EP-VII meeting was dedicated to highlights of the GSICS Research and Data Working Groups, review of the GSICS Operations Plan for 2009 and its associated milestones and action items, as well as an overview of the GSICS Information Services and Product Roster. The EP also focused on nominations for the chairs of the GRWG, GDWG, and EP, the results of which are given in a separate note in this newsletter. Finally, at the onset of the meeting, Dr. Goldberg gave a general presentation on GSICS for the benefit of the new participants in the meeting. He concluded in inviting JAXA and ISRO to join GSICS.

[by J. Lafeuille (WMO)]

EP, GDWG, and GRWG Chair Confirmations

During the Executive Panel Seventh Meeting, it was recalled that at its sixth meeting, the Panel had agreed an update of the Terms of Reference of GRWG and GDWG which included the principle of a three-year term for the GSICS working group and Panel chairmanship, and had discussed potential nominations for the two working group Chairs.

The Panel was pleased to confirm the nomination of:

Aleksandar Jelenak (NOAA) as GDWG Chair,
Tim Hewison (EUMETSAT) as GRWG Chair.

The Panel invited JMA to propose a GDWG Vice-chair. After closure of the meeting, JMA informed the Panel that it had nominated **Ms Hiromi Owada**, Senior Scientific Officer at the System Engineering Division, Data Processing Department, of the Meteorological Satellite Centre of JMA.

As concerns GRWG, the Panel highlighted that GRWG was a very large group and wished to nominate two Vice-chairs to assist the Chair. For a smooth continuity in the GRWG leadership, it was furthermore suggested that the outgoing Chair be one of the Vice-chairs. It was thus agreed that the Vice-chairs would be: **Dohyeong Kim (KMA)** and **Fred Wu (NOAA)**. The Panel renewed its thanks to Dr Volker Gaertner and Dr Fred Wu for their work and leadership as GDWG and GRWG Chair, respectively. The Panel also unanimously agreed to nominate **Dr Mitch Goldberg** as Executive Panel Chair for a new term.

[by J. Lafeuille (WMO)]

Nurturing Global Communications Within GSICS

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GSICS is a partnership currently comprised of nine organizations that span over three continents. It is conceivable that at a given moment different GSICS members are grabbing their morning coffee, running lunchtime errands, and putting their children to bed. But such diverse local activity on a global basis is not unusual. On the other hand, it can be a challenge to share ideas, methodologies, analysis, data, information, plans, etc between people and across thousands of miles … oops, I mean kilometers. So, how have GSICS members managed to coordinate global collaboration to perform common tasks? The answer to this question is nurturing our means of communication.

Communication is the name given to the process by which people share what is in their minds, including ideas and knowledge. The foundation of good communicate is attention, in which the mind can be sensitive to whether or not mutual understanding is being achieved. The tools of communication include a "common system of symbols, signs, or behavior" (Merriam-Webster 2010). For GSICS, this common system includes such things as language; physics, engineering, mathematics and statistics; and imagery, plots, and graphs. In addition, GSICS is critically dependent on modern telecommunications tools and computing protocols.

In GSCIS, the English language has been adopted for all meetings, presentations, documents, results and web sites. Adopting a common language within GSICS has increased our working efficiency and bolstered quality assurance. For example, GSICS inter-calibration algorithm theoretical basis documents are written such that shared ideas or methods between organizations can be consolidated into a single document that is version controlled on the GSICS Wiki. This also allows the document to be reviewed by all GSICS members.

Similarly, most GSICS members share a background in science, engineering, mathematics, statistics and/or computing. Since each of these disciplines has an internationally coherent "language" of its own, communicating concepts, methodologies and data is enhanced tremendously. Furthermore, the experience obtained from performing scientific and computing processes provides a working structure from which GSICS members can confront the technical challenges associated with the GSICS mission.

Without a doubt, GSICS is a product of the digital age we live in. Since most GSICS members rarely meet face-to-face, and more frequent exchanges of plans, methods, information, and data between members is necessary, GSICS relies heavily on modern telecommunications. At GSICS, we have implemented:

- GSICS WMO (*http://gsics.wmo.int*), GCC and GPRC web sites;
- GSICS Wiki (*https://cs.star.nesdis.noaa.gov/GSICS*);
- Organizational and Google Groups e-mail (*gsics-users@googlegroups.com*);
- Standard data format (netCDF), and parameter and file naming conventions (found at *https://cs.star.nesdis.noaa.gov/GSICS*);
- Saba Centra and Web Ex on-line conferencing facilities; and
- Collaboration Servers.

These tools link GSICS members with each other, and the rest of the world.

Since its inception in 2006, GSICS members have made collaborative strides in the research of satellite instrument inter-calibration, and the ability to share the data and information resulting from these studies. Without the ability of GSICS members to nurture global communications, satellite inter-calibration would go back to back to the paradigm of unlinked diverse local activity on a global basis. With global communications, we have the power to transform fragmented weather satellite programs into to a functional part of the Global Observing System of Systems.

[by Dr. R. Iacovazzi, Jr. (NOAA)]

Just Around the Bend …

GSICS-Related Meetings

- **MicroRad, 11th Specialist Meeting on Microwave Radiometry and Remote Sensing of the Environment**, 1-4 March 2010, Washington, DC, USA
- **GPM X-Cal Meeting**, 5-6 March 2010, College Park, MD, USA
- **MSU/AMSU/SSU CDR Workshop**, 22-24 March 2010, Camp Springs, MD, USA
- **CALCON**, 23-26 August 2010 (GSICS Spotlight Session to be held during one day), Utah State University, Logan, Utah, USA.
- **Second GSICS User's Workshop,** To be held as a breakout session during the 2010 EUMETSAT Meteorological Satellite Conference 20-24 September 2010, Córdoba, Spain.

GSICS Publications

Sohn, B.J., S.H. Ham, and P. Yang, 2009: Possibility of the Visible-Channel Calibration Using Deep Convective Clouds Overshooting the TTL. *J. Appl. Meteor. Climatol.*, **48**, 2271–2283.

Please send bibliographic references of your recent GSICS-related publications to Bob.Iacovazzi@noaa.gov.

GSICS Classifieds

Submitting Classified Advertisements: Are you looking to establish a GSICS-related collaboration, or do you have GSICS-related internships, exchange programs, and/or available data and services to offer? *GSICS Quarterly* includes a classified advertisements section on an as-needed basis to enhance communication amongst GSICS members and partners. If you wish to place a classified advertisement in the newsletter, **please send a two to four sentence advertisement that includes your contact information to Bob.Iacovazzi@noaa.gov.**

With Help from our Friends:

The *GSICS Quarterly* Editor would like to thank those individuals who contributed articles and information to this newsletter. The Editor would also like to thank *GSICS Quarterly* European Correspondent, Dr. Tim Hewison of EUMETSAT, and Asian Correspondent, Dr. Yuan Li of CMA, in helping to secure and edit articles for publication.

Submitting Articles to GSICS Quarterly: The *GSICS Quarterly* Press Crew is looking for short articles (<1 page), especially related to cal/val capabilities and how they have been used to positively impact weather and climate products. Unsolicited articles are accepted anytime, and will be published in the next available newsletter issue after approval/editing. **Please send articles to Bob.Iacovazzi@noaa.gov, *GSICS Quarterly* Editor.**